SpaceX Mission Concept Submission: PNPGE - Deep Nuclear Penetration into Europa's Ice

Title:

PNPGE - Deep Nuclear Penetration into Europa's Ice

Principal Investigator (PI):

Vito Angelo Pascaretta

Institution:

HOPR

Mission Objective:

To enable deep access to Europa's subsurface ocean by creating a 100-kilometer vertical shaft through the ice crust using a series of nuclear detonations, combined with natural refreezing to stabilize and seal each stage. The objective includes deployment of robotic probes to assess habitability and search for potential biosignatures.

Scientific Rationale:

Europa is one of the prime candidates in the solar system for harboring extraterrestrial life due to its global subsurface ocean. Traditional drilling techniques are infeasible due to the estimated thickness and extreme conditions of Europa's ice shell. PNPGE offers a scalable, energy-efficient alternative that creates a contained borehole via staged thermonuclear excavation, enabling access within a realistic mission timespan.

Mission Architecture:

- Total Depth: 100 km
- Yield Configuration: Initial detonation (50 Mt), followed by ~66 smaller detonations (10-25 Mt)
- Stepwise excavation with natural refreezing between stages

- Surface base with autonomous control and descent infrastructure

Engineering Phases:

1. Site selection and lander deployment
2. Tsar-class initial crater formation (~1.7 km deep, 6.7 km wide)
3. Sequential detonations (each 1.5 km average depth increment)
4. Refreezing time: 10-30 days per stage
5. Descent of reinforced cable system and robotic probes

Estimated Timeline:

- 2-6 Earth years (including refreezing and system reinitialization time)

Power and Containment:

- Detonation containment achieved via rapid natural freezing of the melt cavity
- Ice environment provides radiological and mechanical shielding
- Energy requirements sourced via onboard nuclear reactor or RTGs for support systems

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Instrumentation:

- Thermal sensors and seismometers embedded at intervals
- Descent winch with autonomous robotic probe
- Submarine probe for subsurface ocean analysis
- Onboard lab for spectrometry, microbiological, and chemical assays

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Expected Outcomes:

- First direct access to Europa's ocean
- High-resolution stratigraphic ice profile
- Potential detection of life or biosignatures

- Validation of scalable deep-access nuclear excavation technology for icy bodies

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Budgetary Notes:

- Cost range: To be determined based on weaponization protocols, international treaties, and mission automation level
- Risk mitigation includes pre-deployment of dummy payloads and remote simulations

Compliance:

- The mission will undergo review for compliance with the Outer Space Treaty and SpaceX's launch and mission safety standards for compliance with the Outer Space Treaty and the Planetary Protection Protocols

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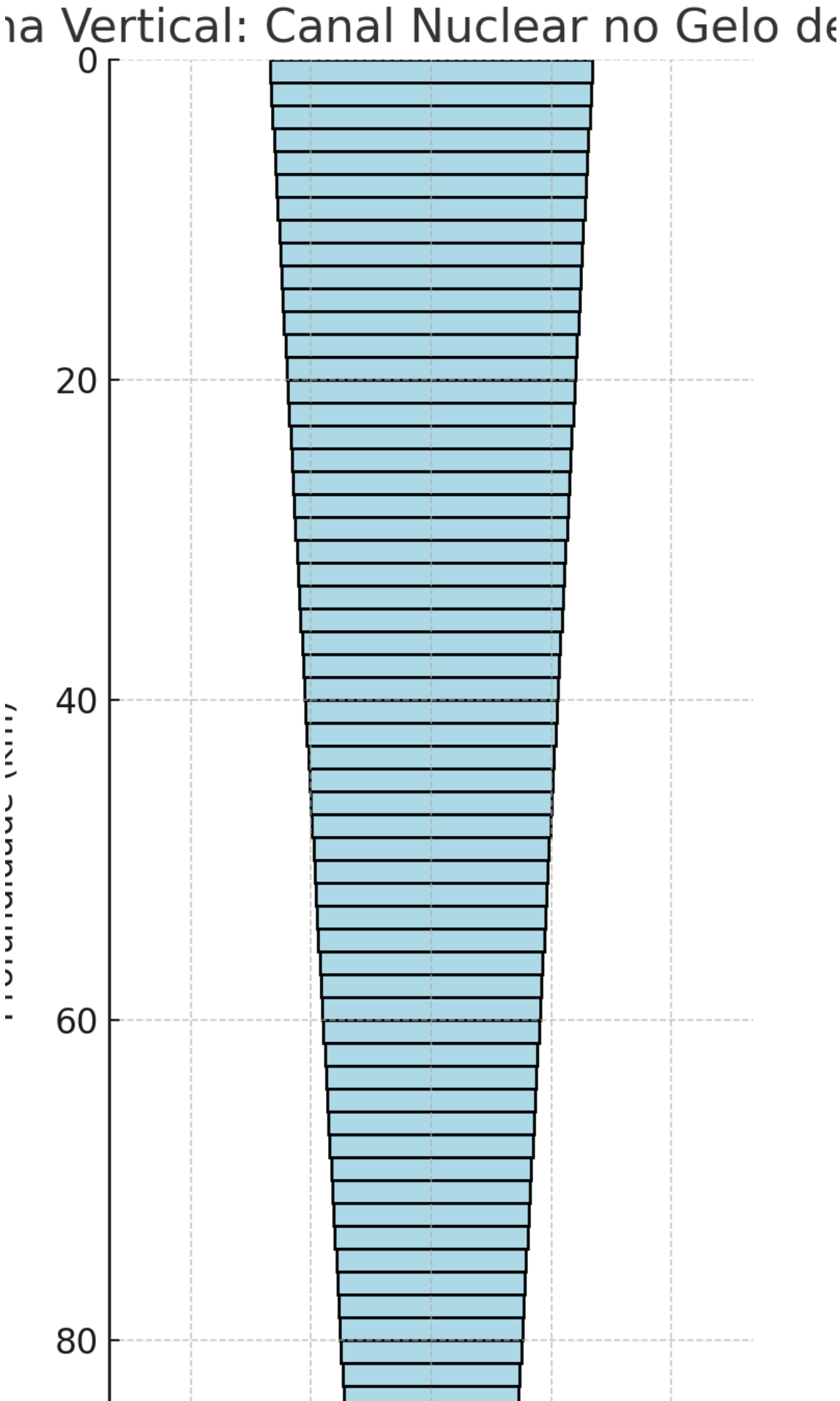
Summary:

PNPGE proposes a novel, high-impact, and scientifically transformative method to probe Europa's hidden ocean using nuclear excavation. Through a robust, scalable, and self-stabilizing channel, this mission will lay the foundation for future exploration of subsurface aquatic environments across icy worlds in the solar system.

Attachments:

- Vertical cross-sectional diagram of channel
- 3D model of excavated tunnel system
- Thermal reconsolidation timeline estimates
- Safety and containment profiles
- Preliminary energy budget and detonation sequencing

Vertical Channel Cross-Section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3D Model of Excavated Tunnel